Critical communications for all professional users

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Critical Communications and Mobile Network Operators

Options for new revenue streams and new market segments

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1 Executive summary

Users of Critical Communications services can be categorised as Mission Critical or Business Critical, or both. Mission critical organisations are for example police forces, fire and rescue and ambulance services, also generically referred to as Public Protection and Disaster Relief (PPDR). Some examples of business critical users include public utilities, oil & gas and transportation companies, but there are many more sectors where critical communications are essential. Within the mission critical segment the key driver is the safety and security of civil society. In the business critical segment the focus is typically on continuity of service of critical infrastructure, and significant economical values are usually at stake. In both segments operational efficiency and effectiveness are also important drivers.

Thus far, critical communications services have been based on dedicated technologies, dedicated networks and dedicated spectrum. The service operators are typically governmentally controlled, which serve only mission critical organisations such as PPDR and related agencies. Some countries also allow business critical use of the network. Existing digital technologies include TETRA, Tetrapol, P25 and DMR, and legacy analogue technologies are still widely used. However, all these are narrowband technologies and hence their capabilities for broadband applications are limited.

Technological and ecosystem evolution is changing the existing critical communications paradigm and also opening up new business opportunities to Mobile Network Operators (MNOs). The next generation of critical communications solutions will be based on 4G/5G technologies and open standards defined by 3GPP. The model of using dedicated networks is being challenged and commercial MNO networks represent a new option for the provision of critical communications services. The lack of dedicated frequency bands for broadband critical communications, especially in Europe, is a driver which also makes MNOs a favourable partner for broadband services. There are already significant next generation critical communications projects ongoing in which MNOs are playing a central role. Examples include the Emergency Services Network in the UK, FirstNet in the US and KPN in Holland for railways.

Existing MNO assets can be a vital prerequisite in the introduction of next generation critical communications services. The technology base is the same as for consumer mobile networks and hence MNOs' existing networks could also be utilised for the provision of mission critical and business critical services, provided that the additional critical requirements on availability, reliability, functionality and security are met. Mission critical services are needed on a nationwide basis and hence comprehensive radio coverage is a prerequisite for fulfilling the service requirements of public safety and other PPDR organisations. In most countries, this would require coverage extensions of existing MNO networks. In addition, the mission critical users expect 100 % service continuity during major incidents, extreme weather conditions or other crisis scenarios. Higher levels of data security and protection against malicious attacks are also required. Altogether, this means that 'hardening' of the commercial networks is necessary. An obvious upside for the MNOs is that by securing the network to fulfil such needs it will also improve the attractiveness of the network for all users.

Within the business critical segment, coverage requirements are typically more concentrated depending on the actual location of the business. For example, to serve an airport or a local transportation company, only local coverage is necessary.

There are many projects either already ongoing or planned for the future in which established PPDR service operators are looking to complement their narrowband services with mobile broadband offering. Often, especially in Europe, the preferred option is to seek collaboration with MNOs. This opens a natural avenue for MNOs to enter the critical communications service market. PPDR service operators have the knowledge of their users' needs, manage the customer interface and operate within the necessary contractual framework which is compliant with operational and legislative requirements, while the MNOs bring economies of scale and knowledge of 4G/5G technology deployment. Another option is to let the MNOs also take larger responsibilities for the support of the PPDR user agencies directly. In both cases, the MNO needs to work together with the authorities to establish the required hardening of the network, which again will benefit the whole society through improved performance also for non-critical communications.

In the business critical segment the go-to-market options can vary widely, depending on the vertical segment, country and the particular customer. MNOs can choose between direct and indirect marketing and collaboration with channel partners, such as for example with existing players within specific vertical markets. As an example, MNOs can provide critical communications services to airport operators either directly, or together with an integrator that is familiar with airports' needs and already has market access.

TCCA represents critical communications users, operators and industry. TCCA facilitates dialogue between the diverse parties involved in the critical communications sector and acts as a forum for open discussion. Due to the increasing role of MNOs within critical communications, TCCA encourages mobile operators to join and cooperate with TCCA's other members. TCCA is a 3GPP Market Representation Partner for critical communications and coordinates critical communications users' requirements in 3GPP standards activities. TCCA is the right forum for MNOs who are looking for new business opportunities within the critical communications market. By joining TCCA and participating in TCCA's activities, including events, Working Groups, and specific operator meetings, an MNO can engage with a large network of highly experienced user organisations, operators and other experts, and leverage TCCA's world-class expertise in critical communications.

2 Scope of the document

This document is intended for Mobile Network Operators. Critical communications service operators and user organisations may also find it useful. The aim of the document is to provide information on critical communications users and potential models for MNOs to address the market. This is to help MNOs to perceive the critical communications market as a potential new business opportunity and the avenue for new revenues streams by utilising the MNOs' existing assets.

The document is divided into following chapters:

- Chapter 3: A short introduction on the different segments of critical communications users, including installed base figures, is given. Two key segments, mission critical and business critical users are introduced.

- Chapter 4: MNOs' new business opportunities within critical communications services are discussed by starting with drivers. Mission critical and business critical segments and their commonalities and differences are covered.

- Chapter 5: MNOs' business opportunities within the mission critical segment are discussed in more detail. A potential collaboration model with a mission critical service operator is presented.

- Chapter 6: The focus of this chapter is MNOs' business opportunities within the business critical segment. The potential offerings and revenue models, as well as the ways to access the market are included in the chapter.

- Chapter 7: The conclusion summarises the findings of the document.

3 Critical communications users

Critical communications users are a heterogeneous group of telecommunications users with some overarching characteristics. So far, the requirements of critical communications users have been special compared to typical mass-market requirements – consumers and enterprises. One of the most typical requirements and a common one among critical communications users is the need for group communications. For example, for police officers in the field, the ability to communicate with several users at the same time, reliably and without delay is a cornerstone of the existing operational models of police forces.

The special requirements of critical communications users have led to dedicated, fit-for-purpose technologies, traditionally called PMR or LMR (Professional Mobile Radio, Land Mobile Radio) networks. There remain many conventional analogue network users, while digital technologies have been gradually replacing analogue ones. The global installed base of licensed critical communications devices in 2017 was 47.9 million, of which the share of analogue devices was still 48.1 %, with the rest being digital technologies, such as TETRA, Tetrapol and P25[1].

Critical communications users can be divided into two main categories depending on the user organisations. One of these groups is **Mission Critical** users with the other being **Business Critical** users. Public safety and PPDR[2] is often used as a synonym for mission critical. Typical mission critical users are police, fire service and rescue, ambulance and border guards. Usually their requirements for the reliability, security and performance of the system are the most rigid of all users and their coverage need is inherently nationwide. Business critical users are often looking for solutions that balance performance and price and hence their requirements can be somewhat relaxed. For most of them the coverage need is local. There are different vertical businesses among the business critical users, for example infrastructure utilities (energy, oil & gas), public transportation, airports and industrial companies. Also within the business critical segment very demanding users can be found, for example railways are likely to have very strict requirements when they seek to include train control functions.

[1] "Licensed Mobile Radio Terminals- World- 2017", IHS Markit Technology, 4 January 2018

[2] Public Protection and Disaster Relief

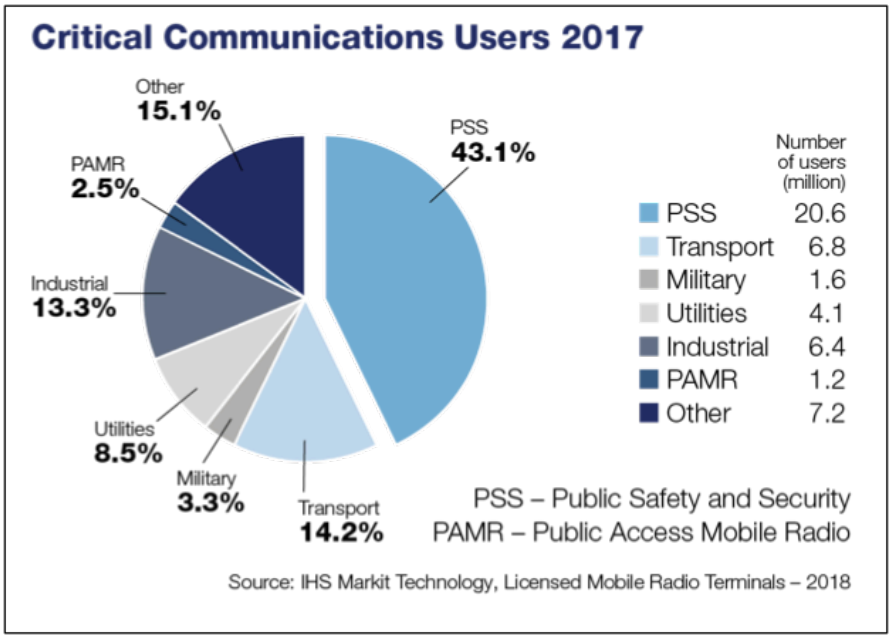

Figure 1. Critical Communications users 2017

The share of mission critical users (public safety and military) in the device installed base was 46.4 % globally in 2017. The next biggest user groups are transport (14.2 %), industrial users (13.3 %) and utilities (8.5 %)[3]. Users of GSM-R technology are not included in these figures.

[3] "Licensed Mobile Radio Terminals- World- 2017", IHS Markit Technology, 4 January 2018

4 Mobile Network Operators' new business opportunities

4.1 Drivers

Critical communications users, both mission and business critical, are looking for solutions which improve their operational efficiency and safety of people in the form of new communications capabilities, new applications and new devices. Mobile broadband is the key technical enabler here.

The key deployment options of critical mobile broadband services are to either have dedicated spectrum and a dedicated network or to use the services provided by MNOs. With the MNO option, there is no need for dedicated spectrum or a dedicated radio network. Today, the availability of dedicated spectrum for critical communications broadband is very limited around the world, making collaboration with MNOs a natural choice. Although there may be dedicated spectrum available for critical communications, it can even then be a justified decision to take a mobile operator as a partner with its existing mobile network and expertise on network operations and services. For example in the US, dedicated spectrum is made available to an operator on special terms.

MNOs around the world are looking for new opportunities for business growth: that is, new revenue streams with a healthy margin. MNOs have many options for new businesses, critical communications being one of the promising ones. In a survey of 100 MNOs about their plans for 5G adoption[4], there were questions about the most potential 5G use cases. Not surprisingly, operators' existing business, mobile broadband, topped the list of answers (64 % of responders). Perhaps a small surprise was that the next largest opportunity cited as a new potential business is public safety, with 41 % support. The others were business critical cases such as remote operations in health care, real-time remote control, smart buildings and smart cities. The survey also revealed that operators are looking for new businesses beyond the existing consumer-driven services. The outlook of 47 % of responders is that 5G is primarily enterprise driven. This is a major change in thinking compared to the existing operators' business, which is clearly dominated by consumers.

In addition, MNOs' role in the latest mission critical mobile broadband projects reveals that operators see mission critical services as a significant new business opportunity to complement their existing businesses, for example in the UK's ESN, FirstNet in the US and SafeNet in the Republic of Korea. One of the operators' future options is to combine several new services to create added value for new customer segments. For example, critical communications could be complemented with IoT, smart city and smart building services. This would increase operators' business potential and would also create added value for critical communications users.

[4] "Number Theories: what 100 operators really think about 5G"; Ericsson Business Review; Issue1; 2016

4.2 Mission critical and business critical users – the potential MNO segments

Figure 2 describes the critical communications segmentation from the MNO's viewpoint. There are three different segments of PTT (Push-To-Talk) users: Consumer market, business critical users and mission critical users. From the MNO's viewpoint, these are segments with different requirements, the number of potential users is different and the expected ARPU (Average Revenue per User) is also different.

The most challenging segment is mission critical users, who demand high availability, elevated QoS (Quality of Service), prioritised access, large coverage, and high security and performance. The number of potential mission critical users, for example police, fire and rescue and ambulance services, is likely the smallest among these three segments. On the other hand, serving mission critical users provides the MNO an opportunity for diverse benefits. These vary from country to country depending on the starting point and government policy. Benefits can include premium ARPU from mission critical users, access to additional spectrum which may also be used by the MNO's other customers, or government-financed network hardening and/or extended coverage. A network with improved coverage and resilience is at a competitive advantage not only with public safety users but also with consumer and enterprise customers and within the business critical segments such as critical infrastructure, energy, public transportation, etc.

Business critical users typically have special requirements such as high reliability, particular operational needs and good coverage, although the coverage need can be regional or local. Here the needs of different verticals can vary a great deal. Mostly, business critical users are willing to pay a premium for the service level exceeding the standard consumer one, although they are looking for a balanced solution between service price and quality.

The third segment of potential PTT users comprises the consumers. Their use cases are not critical and hence they have no special requirements. Consequently, they do not want to pay a premium fee on top of standard billing plans. Typically, consumers use over-the-top PTT applications, which can be free of charge. Hence, business-wise they are a less attractive segment for an MNO seeking to provide PTT services, as additional ARPU is limited.

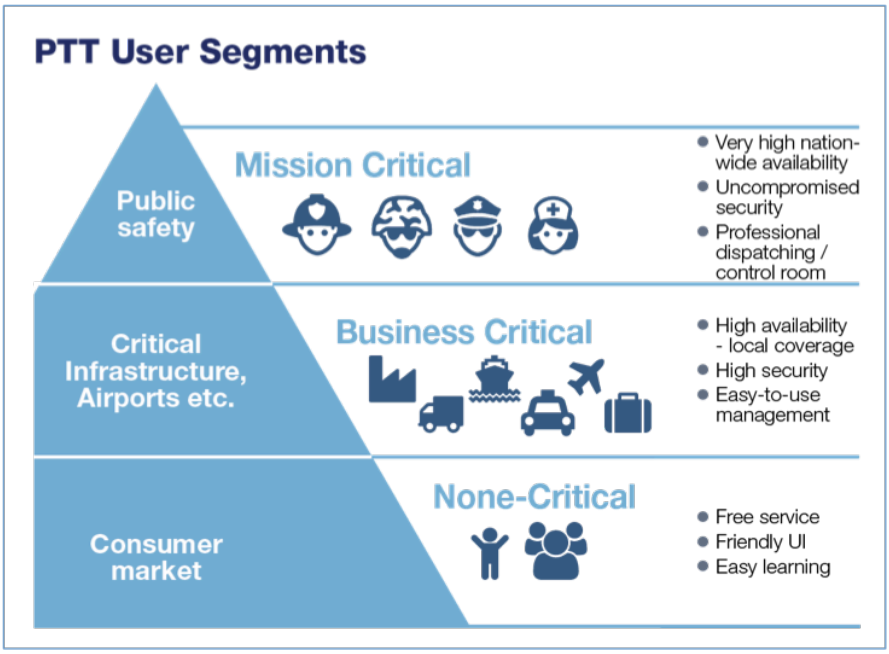

Figure 2. Different user segments of PTT services

4.3 Positioning of mission critical and business critical segments

As illustrated by Figure 2, mission critical nationwide service is the pinnacle of critical communications. Business critical users come right underneath the mission critical segment in that it also imposes stringent requirements, although most often it is not about lives being at stake and typically the magnitude of the exposure is less. If we compare business critical and mission critical users on a few key aspects, the distinction becomes apparent, as described by the Table 1.

Mission vs. Business Critical

	Mission Critical	Business Critical
Target segment	Public Safety	Corporates, utilities, transportation, airports, etc
Coverage	Nationwide	Partial and local
Potential users	Public Safety users; typically 10.000´s–100.000´s per country	Corporate staff; typically 1000´s or some 10.000´s per organization
Potential providers	MNOs in co-operation with Public Safety Service Operators	MNOs, Segment specific service providers, Service Providers with aaS offerings
Provider market maturity:	Depends on the country, in Europe mostly established	To be developed, fragmented

Table 1. Comparison of mission critical and business critical user segments

To illustrate the- sometimes vast – difference in coverage requirements, Figure 3 illustrates an imaginary country with mission critical and business critical coverage needs.

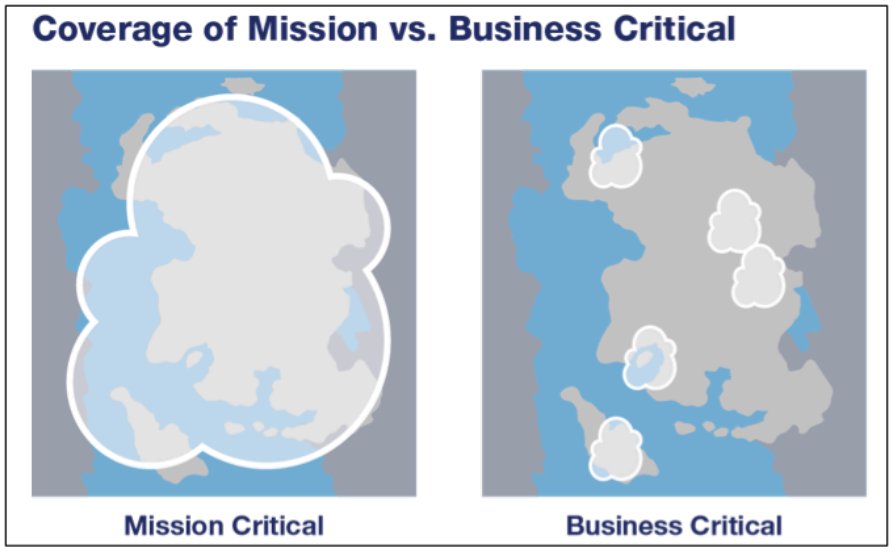

Figure 3. Coverage needs of typical mission critical and business critical users

Clearly, there are also 'in between' cases, an obvious one being a 4G service for a railway. This will require coverage throughout the country, along all tracks, though not everywhere in the territory in question. If the railway's communications service encompasses train control, thus replacing GSM-R, the case becomes close to mission critical in the sense that lives may be at stake. An airport is an interesting example of the opposite: a very dense usage of critical mobile services across just a few square kilometres, theoretically easily provided through a few hardened

(e.g. improved resilience) base stations and some new software capabilities in the network. This distinction in positioning between mission critical and business critical leads to interesting and almost opposite **engagement strategies** and options for MNOs.

Top down
If an MNO can provide nationwide mission critical mobile broadband to the entire public safety sector, it is likely to have the network and services in place to also serve business critical verticals. This is also recognised by the GSMA in a white paper[5]:

> *"To ensure that sufficient efforts are made in building resilient products, it is vital that the use of mission critical communications is not restricted to a relatively small market such as public safety, but rather that benefits from economies of scale are fully leveraged so that the additional development costs necessary for guaranteeing the desired quality are shared across a larger user base."*

Ongoing nationwide next generation PPDR projects such as the UK's ESN and FirstNet in the US are good examples of building for the most challenging users.

Bottom up
The MNO interested in engaging the new and demanding market for mission critical and business critical services may also start with the business users: the corporates and verticals that have less stringent requirements. To provide a first critical 4G service to an airport or a hospital may require the hardening of as few as five or ten base stations and associated new capabilities that enable the provisioning of mission critical PTT services to some thousands or tens of thousands of users. Gaining experience here is a more controlled and gradual approach than the previously described top down one. Once the MNO gains traction in these sorts of customers, it can expand the service to identical corporates, for example, expanding from one into multiple hospitals and then diversifying into adjacent or similar verticals.

The MNO may very well decide to do this in partnership with a service provider with a thorough knowledge of a particular vertical, and the MNO may even collaborate with one provider per vertical per country. The health sector is a likely candidate for development per country as there are no pan-European, let alone global, health service providers. This bottom up approach would allow the MNO or the service provider to gain experience and control its exposure whilst establishing itself as a critical communications service provider.

In support of the 'bottom-up' strategy, it may be noted that in verticals and in industry, often the business case behind a transition to an enterprise 4G services or a business critical network can be more readily justified by demonstrating benefits such as efficiency and reduced operational expenses. This means that the readiness to pay for a business critical service is more obvious in the enterprise case.

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[1] "Network 2020: Mission Critical Communications", GSMA, January 2017

5 Business opportunities within the mission critical segment

Today, a typical way to arrange mission critical services is to have a governmentally controlled organisation that manages the provision of services to public safety authorities. Usually the same agency serves different user organisations, such as police, fire & rescue and ambulance services. The organisation can be a governmentally owned operator, a government body or maybe even a private company with a service agreement with a government. Usually the service organisation oversees the daily operations, maintenance of the network and end-user services, for example, a 24/7 service desk. User devices can be deployed via the service organisations, or can be purchased directly. These service organisations within public safety are often well established.

For user organisations, the key point is trust. A service operator of mission critical services deals with highly confidential information, such as that related to the tactical operations of police forces. It must be 100 % sure that confidential information does not leak out to unauthorised parties. In addition to confidentiality, another key point is the high service availability needed by mission critical operations. For example, occasionally the radio device is literally a police officer's lifeline. In those situations, when they push the button on their radio, they simply must get an immediate connection.

To make the service operator accountable for the service level, confidentiality and other terms, there is usually a Service Level Agreement (SLA) between the service operator and user organisations. In many countries, there can also be legislation, which defines the mandate and authorities of the service operator.

The most straightforward way for an MNO to introduce mission critical broadband services is to collaborate with an existing mission critical service operator. The MNO takes care of the mobile broadband services and the service operator offers the necessary mission critical services on top of the MNO's services. The service operator is in charge of new services provided to the user organisation as a whole. Hence, the existing SLA and other agreements can also be applied with broadband services. This is a convenient arrangement for user organisations. Between the MNO and the service operator there also needs to be an SLA agreement on the services the MNO provides to the service provider. Naturally, the service level and other terms need to be aligned with the SLA the service provider has with user organisations. In a previous white paper[6], TCCA has listed typical conditions used in today's agreements (see chapter 5 of the paper).

The collaboration between an MNO and a service operator can take place within very different operational models depending on the country and MNO specific preferences. Procurement models can also vary greatly, with the local government and regulator having a major influence.

[6] "Considerations for Government Authorities when they are planning to acquire Mission Critical Mobile Broadband Services", the reference can be found in the More information chapter

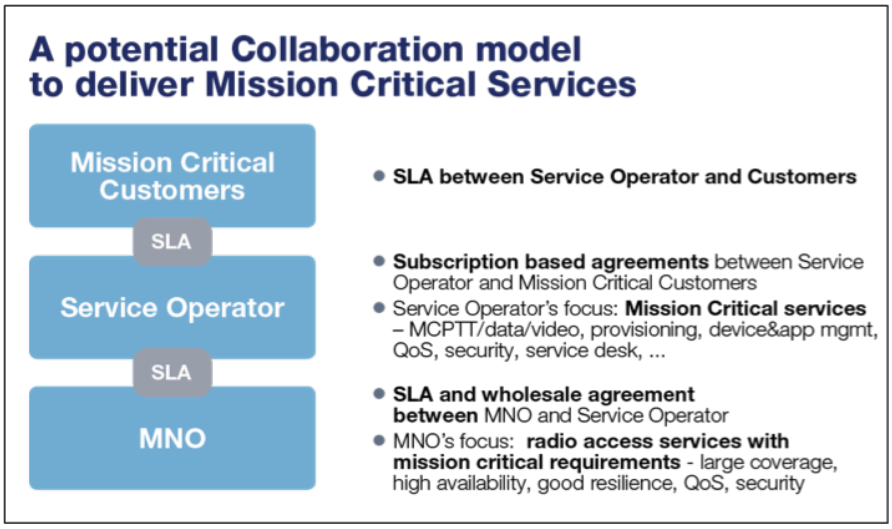

Figure 4. A potential collaboration model to deliver mission critical services

In the collaboration model illustrated in Figure 4, the share of responsibilities resembles a Mobile Virtual Network Operator (MVNO) operator model, in which there is a wholesale agreement between MNO and MVNO, here the service operator, with the MVNO addressing their own customer segment. Here, the service operator serves mission critical customers and they have an SLA both with the MNO and with the mission critical user organisations. Naturally, these SLAs are fundamentally different:

- The focus of the MNO is on high-quality radio access services by considering the special requirements of mission critical users- large coverage, prioritisation, high availability and reliability and high security. However, the model is close to the model the MNOs are familiar with from MVNOs.

- A service operator provides the integral services needed by mission critical customers. These include group communications services (MCPTT, MCVideo, MCData), provisioning solutions to manage organisations, groups and subscribers, device and application management, QoS management and a service desk for users. If the service operator is an organisation, which already provides mission critical (voice) services to user organisations, the change is smooth. The existing organisation model and agreements can be used, with the possible addition of some extensions. This is also an easy route for end-user organisations.

The described model assumes that the MNO collaborates with a service operator who provides mission critical services to PPDR users. This helps the MNO to focus on its key capabilities and its familiar business model while the service provider takes care of the capabilities needed for mission critical users. Another model for the MNO is to take care of the whole value chain and provide mission critical services without support from a service operator partner. In such a case the MNO needs to hold a larger set of capabilities to be able to directly serve PPDR users.

6 Business opportunities within the business critical segment

6.1 Modes of offering critical services and candidate revenue models

The following are three typical ways to offer mobile communications services to the business critical market:

- Managed network
- Managed service
- Full service offering

Figure 5 positions the offerings in terms of hardware vs. service and of the autonomy of the end user.

Business critical verticals have been accustomed to paying for their critical services, today mostly voice, with premium tariffs. After all, critical communications is vital to their processes, and the cost associated with missing out on communication can be very significant. The business critical segment may therefore be interested in alternative solutions for their critical communications, if there is a clear, calculated and proven business case for them.

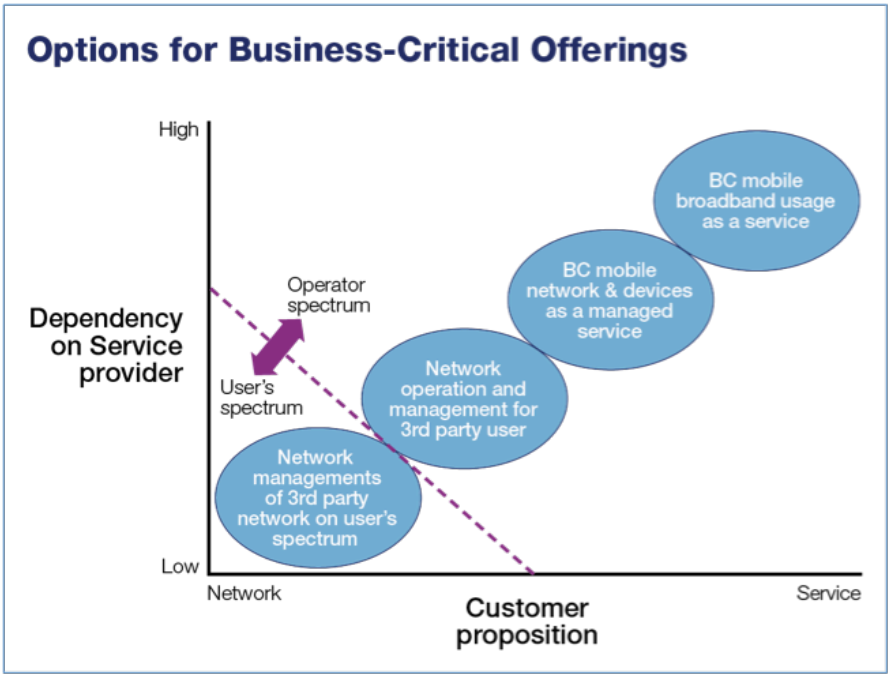

Figure 5. Options to deliver business critical communications services

Managed network:
An MNO already has a 3G/4G (later on 5G) network with nationwide coverage. With this, it can offer a managed network to business critical users.

The network offered to business critical users often has to meet stringent requirements and inevitably then has to be 'hardened', that is, with better availability, coverage and redundancy. This comes at a higher price, which the end users will pay as it facilitates their precious operational processes.

There are two types of managed network when it comes to spectrum:

- **Operator spectrum:** The operator already possesses spectrum from auctions or allocation, with which it can offer a segment-specific network under an SLA.
- **End-user spectrum:** The end user may have spectrum available for establishing its own private network, acquired through a licence or from a national arrangement.

Managed Service:
The entire business critical network can be provided as a fully managed service. Most probably, here as well the spectrum will be that of the operator. The network provided can be either a dedicated 'slice' of the MNO's existing network and service or a hardened separate network with raised performances.

Devices:
With the above critical network or managed services comes a portfolio of devices. Until recently, business critical users had only their fleet of voice devices to manage. Soon however, there will be many other devices, ones that enable push-to-video, logging devices and body-worn cameras. End users will increasingly be tempted to outsource the management of their devices to a comprehensive service provider.

Full service offering:
All the above can also be offered as a fully managed and outsourced operational service where the end user organisation pays an annual or monthly fee per user or per device for both connectivity and the devices as well as additional services. Here, the operational usage in the end user's processes becomes the key. The operator will likely manage and implement all sorts of additional services, meaning that a contract is written as an SLA with performance indicators and fees that reflect the inherent value to the user.

6.2 Market access within business critical segment

There are two fundamentally different ways an MNO can access the business critical services market:

Direct marketing:
With its offering as elaborated above – network, devices, full services – the MNO can directly approach selected verticals, such as the national transportation sector or the health segment. This requires account teams and fulfilment processes that are geared towards targeted segments. If the effort related to this segment specific marketing is perceived as a hurdle, then the next option becomes valid.

Indirect or channel marketing
There are niche service providers that have been around in specific sectors for decades and have developed a targeted approach for just their segment. They have the organisation to access the niche, have the flexibility it requires to serve 'just' thousands of users and have the credibility within their sector to be a trustworthy partner. These service providers may well be the perfect channel for the operator to market its offering to a segment. For the MNO this avoids having to invest in a tailored sales organisation and allows the operator to benefit from an already established position in the segment of the chosen services provider.

Channel marketing is likely to be a viable option for MNOs to engage the business critical users.

Business critical offering and channels

In the past, most business critical users have procured and operated their own critical communications systems and used them predominantly for voice. This is why many of these users have their own PMR systems, Wi-Fi based data systems, proprietary systems or analogue incumbent systems. In addition, most of them also use mobile data subscriptions. These users would be open to streamlining their systems – migrating their legacy systems into a single coherent environment – provided that their needs for communications services would be met. LTE (i.e. 4G) is evolving as the natural candidate to meet those needs.

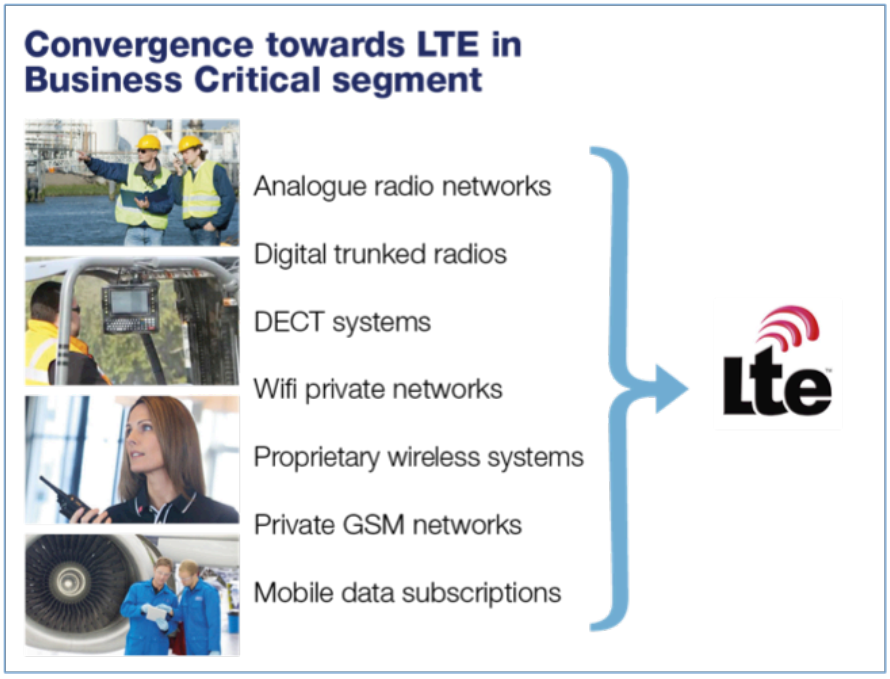

Figure 6. Convergence towards LTE in business critical segment

To arrive at this converged business critical mobile broadband future the organisation can continue to source solutions itself, but can also shift towards as-a-service (aaS) proposition from those players that already possess LTE networks and/or operate business critical broadband services.

In other words, this would be the Full service offering explained in chapter 6.1. The customer and the provider would agree on a set of KPIs under a service contract.

Many industries are already shifting towards aaS type propositions. Business critical communications is following the same trend.

For the business critical customer, the aaS proposition will mean that they depend on a third party to deliver the communications that are the basis of their vital corporate processes. They will require 'hardened' networks and set demanding KPIs, and they will need to trust the provider. MNOs may choose to provide these hardened services and KPIs themselves. Then again, there may be credible service providers that are well positioned to provide a business critical mobile broadband service to a range of similar verticals. Most likely, these are service providers that are specific to a vertical, like airports, public transport or health. These service providers may soon develop further as the demand arises, as illustrated by Figure 7.

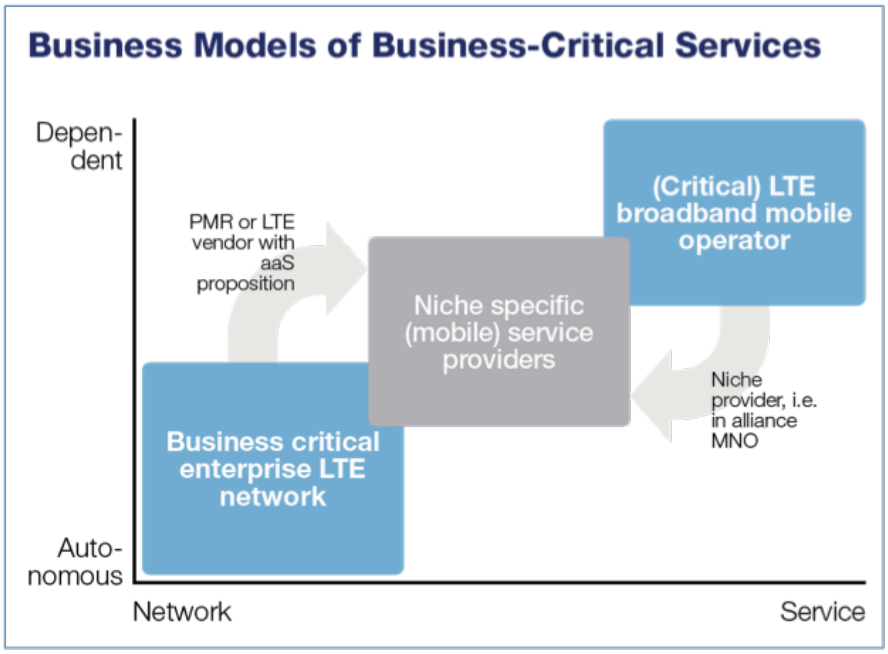

Figure 7. Business models of delivering business critical communications services

Such segment-specific service providers can develop from two different backgrounds:

- Existing players within a vertical that team up with an MNO to offer essential communications services to the designated vertical.
- Established vendors with profound PMR/LMR experience that develop an aaS offering for a vertical, or could emerge from scratch as new entrants.

There is some material[7] that supports the notion of new players entering the market in an era where mobile services become segment specific and essential to businesses.

[7] E.g., a study from CERRE (European regulatory) into disruptive new service provisioning roles with new entrants and new service aggregation players; an EU study into future spectrum allocation models that develops (amongst others) a scenario called driven by verticals; a white paper by the GSMA on the potential of the mission critical market

7 Conclusion

Mobile network operators will play a key role in next generation critical communications solutions – this is already proven by three major current national projects in the US, UK and Republic of Korea. Corresponding setups are also being discussed and planned in several other countries, especially in Europe. Several aspects linked to the evolution of critical communications are summarised below.

1. Critical communications users are looking for solutions which improve their operational efficiency and safety of people in the form of new communications capabilities, new applications and new devices. These are the underlying drivers for the evolution towards 4G/5G-based critical communications solutions.

2. Spectrum is a scarce resource and the trend, at least in Europe, is clearly to auction spectrum to commercial MNOs. Some countries will also grant dedicated spectrum for critical communications. It looks like spectrum sharing between consumers and critical communications users is the best way to find an economically feasible solution for broadband critical communications users.

3. Critical communications can be divided into two parts: Mission Critical and Business Critical. The technical requirements are similar, but otherwise there are significant differences. Business critical implementations are typically smaller by number of users, radio coverage is required for a smaller area and decisions are more business case and ROI-driven when compared to the more security-driven mission critical part of the market. This also means that projects within these sub-segments may have different business cases for MNOs.

4. Market access is essential for MNOs to enter into the critical communications business. In the mission critical segment, the most straightforward way for an MNO is to collaborate with an existing mission critical service operator. In the business critical segment the options can vary, depending for example on the vertical segment, country and the customer. MNOs can choose between direct and indirect marketing and collaboration with channel partners, e.g. with existing players within specific vertical markets.

5. To satisfy the requirements on coverage, availability, reliability and security, it is likely that additional investments are required in existing commercial mobile networks. This provides the MNO an opportunity for diverse benefits. Depending on the country, these can include premium ARPU, access to additional spectrum which can be also used with the MNO's other customers, or government-financed network hardening and/or extended coverage. A network with improved coverage and resilience is a competitive advantage not only with public safety users but also with other user segments.

6. TCCA is an organisation representing critical communications users, service operators and industry. TCCA facilitates the dialogue between diverse parties and is a forum for open discussion. Due to the increasing role of MNOs within critical communications, TCCA encourages MNOs to join TCCA and collaborate with other members. TCCA also coordinates the critical communications users' requirements in 3GPP. TCCA is the right forum for MNOs who are looking for new business opportunities within the critical communications market. By joining TCCA and participating in TCCA's activities (such as events, Working Groups, and specific operator meetings), an MNO can engage in a large network of highly experienced user organisations, operators and other experts, and leverage TCCA's world-class expertise in critical communications.

Today's focus on the evolution of critical communications is much on standardisation and network solutions. However, it is important to understand that in the long run, significant parts of the user value will be delivered by different kinds of applications that not only enhance productivity, but more importantly enable public safety officers and other critical communications users to fulfil their critical tasks in better ways.

8 More information

More information can be found in the following documents:

- TCCA, March 2017; "4G and 5G for Public Safety- Technology Options"
  https://tcca.info/tetra/tcca-news-and-resources/

- TCCA, March 2017; "Hybrid Study- A discussion on the use of commercial and dedicated networks for delivering Mission-critical Mobile Broadband Services"
  https://tcca.info/tetra/tcca-news-and-resources/

- TCCA, July 2016; "A review of the Spectrum Status for Broadband PPDR in Europe"
  https://tcca.info/tetra/tcca-news-and-resources/

- TCCA, December 2015; "Considerations for Government Authorities when they are planning to acquire Mission Critical Mobile Broadband Services"
  https://tcca.info/tetra/tcca-news-and-resources/

- ECC, October 2015; ECC Report 218: "Harmonised conditions and spectrum bands for the implementation of future European Broadband Public Protection and Disaster Relief (BB-PPDR) systems"; Section 5
  http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP218.PDF

- European Commission, report by SCF Associates Ltd, 2014; "Is Commercial Cellular Suitable for Mission Critical Broadband?"
  https://www.researchgate.net/publication/289540175_Is_Commercial_Cellular_Suitable_for_Mission_Critical_Broadband_Final_Report_to_the_European_Commission

- European Commission, report by LS Telecom et al., 2017: "Study on Spectrum Assignment in the European Union"
  https://ec.europa.eu/digital-single-market/en/news/wide-range-spectrum-authorisation-approaches-will-help-achieve-full-benefits-future-5g-use

- Centre on Regulation in Europe (CERRE), March 2017, "Towards the successful deployment of 5G in Europe: What are the necessary policy and regulatory conditions?"
  http://www.cerre.eu/publications/towards-successful-deployment-5g-europe-what-are-necessary-policy-and-regulatory

Abbreviationss

3GPP	Third Generation Partnership Project
4G	Fourth Generation
5G	Fifth Generation
aaS	as a Service
ARPU	Average Revenue Per User
DECT	Digital Enhanced Cordless Telecommunications
ECC	Electronic Communications Committee
ESN	Emergency Services Network
GSM-R	Global System for Mobile Communications- Railway
IoT	Internet of Things
KPI	Key Performance Indicator
LMR	Land Mobile Radio
LTE	Long Term Evolution
MCPTT	Mission Critical Push-To-Talk
MNO	Mobile Network Operator
MVNO	Mobile Virtual Network Operator
PMR	Professional Mobile Radio
PPDR	Public Protection and Disaster Relief
PTT	Push-To-Talk
QoS	Quality of Service
ROI	Return On Investment
SLA	Service Level Agreement
TCCA	The Critical Communications Association
TETRA	TErrestrial Trunked Radio